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National Occupational Analysis

Welder

2014

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National Occupational Analysis

Welder

2014

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis (NOA) as the national standard for the occupation of Welder.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. To this end, Employment and Social Development Canada (ESDC) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs.

The NOAs have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

ACKNOWLEDGEMENTS

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This analysis was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division. The host jurisdiction of Newfoundland and Labrador also participated in the development of this NOA.

Comments or questions about National Occupational Analyses may be forwarded to:

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To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	the largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	a list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Context	information to clarify the intent and meaning of tasks
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	a non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	a list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	a graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from ESDC. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Draft Review

The NOA development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
SUB-TASKS	Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

YES	sub-task performed by qualified workers in the occupation in a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
NATIONAL AVERAGE %	average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

NL	Newfoundland and Labrador
NS	Nova Scotia
PE	Prince Edward Island
NB	New Brunswick
QC	Quebec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
NT	Northwest Territories
YT	Yukon Territory
NU	Nunavut

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

SCOPE OF THE WELDER TRADE

"Welder" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by welders whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Industrial Welder							✓						
Welder	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

Welders permanently join pieces of metal by applying heat, using filler metal or fusion processes. They join parts being manufactured, build structures, and repair damaged or worn parts. They use various welding processes to join structural steel and metal in vessels, piping and other components. They also use various cutting and gouging processes as well as fabricate parts, tools, machines and equipment used in the construction and manufacturing industries.

Welders may specialize in certain types of welding such as custom fabrication, ship building and repair, aerospace, pressure vessels, pipeline, structural welding, and machinery and equipment repair.

They may contract or be employed by companies such as fabrication shops, steel and platform manufacturers, petrochemical refineries, mechanical contractors, transportation contractors (heavy machinery, aircraft, shipbuilding, railcar repair), and specialized welding shops. Their work may be performed outdoors or indoors, and travel may be required to jobs in remote locations.

In order to meet high quality standards, welders require attributes such as good mechanical ability, manual dexterity, good vision, excellent hand-eye coordination, and the ability to concentrate on detail work. They should be able to work independently or as part of a team. They also require the ability to work efficiently and accurately, to visualize a finished product, to reason logically and to understand metallurgy.

Occupational hazards in this trade include: sparks, gases, hazardous fumes, burns, heavy lifting, repetitive stress and exposure to ultra-violet and infra-red radiation. Environmental conditions may include working at heights, in confined spaces, in trenches and in extreme temperatures.

With experience, welders may advance to positions such as lead hand, welding supervisor, welding inspector and project manager.

This analysis recognizes similarities or overlaps with the work of industrial mechanics (millwrights), sheet metal workers, steamfitters/pipefitters, metal fabricators (fitters), ironworkers and boilermakers. With additional training, welders can transfer their skills to these related trades.

OCCUPATIONAL OBSERVATIONS

Technological advances have resulted in energy efficient and light welding equipment. Computers and microprocessors are now being incorporated into power sources. New options in welding automation have resulted in improved quality of welds, better repeatability and consistency, increased production and less down time. Also, digital communications between systems' components make them faster and more flexible than previous analog systems.

Advances in pulsed welding technologies are providing high quality welding performance on aluminium, stainless steel and other alloys. These technologies improve productivity, operator efficiency and cost-effectiveness.

Modified short-circuit welding is a new technology that produces high quality welds with minimal spatter and high productivity. Another benefit of this technology is that it may eliminate the need for back purging gas on stainless steel.

Welders work with a greater variety of alloys. There is a need for strict adherence to procedures and specifications to maintain the metallurgical and mechanical properties of these alloys.

Environmental issues continue to be a major focus in the welding industry. There is also growing emphasis and awareness placed on workplace health and safety. For welders, this requires additional training, improved practices for recycling and disposal, and more stringent government regulations.

ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

Tools are available online or for order at: http://www.esdc.gc.ca/eng/jobs/les/tools/index.shtml.

The application of these skills may be described throughout this document within the competency statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

Reading
Welders read documents to understand and learn. For example, they read WHMIS material to find out how to handle hazardous products, as well as equipment and safety manuals to understand safe operating procedures. They also read and interpret complex information found in codes and regulations.

Document Use
Welders refer to checklists to follow proper work procedures and to track the progress of projects. They interpret the significance of information found on various documents. For example, they look for safety information on signs and project status on tags, they observe colours on pipes, lines and metals to determine their contents or grade, and they refer to markings such as stamps, metal plates, or tags. They complete forms and reports such as invoices, time sheets or daily logs to record information. Welders interpret symbols and numbers found on drawings to determine material requirements and measurements as well as the welding process to be used and the type, size, location and position of welds. They also review engineering notes found on drawings, or welding procedures specifications (WPS) and welding procedures data sheets (WPDS).

Writing
For the most part, welders write text requiring less than one paragraph. For example, they fill in information in invoices, reports, time sheets and daily logs. However, they may have to complete accident and incident reports, or write safety guidelines, which require writing of more than one paragraph.

Oral Communication
Welders communicate with co-workers and others on a daily basis to give directions, ask for assistance, provide information and guidance, and discuss work assignments. They may give informal presentations or explain welding designs to customers. They may also coach and mentor apprentices by demonstrating and explaining work procedures and expectations.

Welders often work in noisy environments caused by machinery such as mobile equipment, grinders, hammers, sandblasters and moving metal, which affects communication. Therefore, welders use hand signals to communicate whenever necessary, particularly from a distance.

Numeracy
Welders use money math to calculate the charge for materials and labour when preparing invoices. They also use measurement and calculation math. For example they measure degrees of angles, lengths of pipe and elevations. They use various formulas to calculate how to get the maximum number of pieces out of a length of pipe, the dimensions of structural members, the volume, diameter and circumferences of tanks when fabricating pieces for them, and offsets. They may work with the metric and imperial measurement systems and therefore must be able to convert between the two systems. Welders also use numerical estimation to estimate the quantity of consumables required, the weight of a load based on its size and density, and the cost of work based on material and labour requirements.

Thinking Skills
Welders use problem solving skills to identify discrepancies in drawings. They troubleshoot problems with equipment and generate unique solutions depending on the situation.

Welders use decision making skills to decide whether they have enough information to start the task immediately or whether they need to gather more information first. They decide on the most efficient use of materials and how to control the temperature during the welding process to avoid metallurgical problems. They may also decide on the best way to approach a job in consultation with their supervisor and any work partners.

Welders use planning skills to organize and set up their work area, gather materials and equipment, and work on alternative tasks if equipment is not available.

Working with Others
Welders mostly work independently within a team environment, which includes other welders, supervisors and other tradespeople such as steamfitters/pipefitters, to plan work, confirm calculations and to schedule the sharing of equipment. They may coach and receive assistance from apprentices. They may also be partnered with someone from another trade, such as a

steamfitter/pipefitter, to co-ordinate their tasks on projects so that steps are completed in the correct order.

Computer Use

Welders may use computers for research, data entry and viewing trade documents. They also use electronic communication software to communicate with customers and suppliers.

Continuous Learning

Welders may attend information and training seminars hosted by suppliers about new products. Employers also provide training specific to their company such as company policies, confined space entry, helicopter safety and H_2S Alive. Welders must upgrade their knowledge and skills on an ongoing basis because of new innovations in consumables, and welding applications and processes. They may learn by researching technical information on the Internet, participating in formal training opportunities or informally on the job.

Welders are required by various codes to recertify or upgrade their qualifications within a specific period of time. Study and practice may be required in preparation for these tests.

Trends

There is an increase in safety awareness resulting in a higher demand for training and certification.

There is a greater emphasis on the use of personal protective equipment (PPE) due to a greater awareness of occupational hazards and increased regulations.

Documentation and reference materials are easier to access due to the increase in computer and Internet use.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 1 Maintains tools and equipment.

Context

Welders must maintain tools and equipment in order to keep them in safe working condition.

Required Knowledge

K 1	hand tools such as chipping hammers, wire brushes, files and clamps
K 2	electric power tools such as grinders, drills and saws
K 3	pneumatic power tools such as grinders and drills
K 4	hydraulic power tools such as punches and shears
K 5	power tool attachments such as grinding discs and drill bits
K 6	stationary machinery such as pedestal grinders, shears, drill presses, band saws, hacksaws, brakes and ironworkers
K 7	layout tools such as squares, dividers, levels and trammel points
K 8	measuring tools such as calipers, weld gauges, steel gauges and measuring tapes
K 9	location of lubrication points
K 10	types of lubricants such as grease and gear oil
K 11	types of coolants

K 12	WHMIS and jurisdictional environmental regulations
K 13	manufacturers' maintenance procedures for tools and equipment
K 14	types of cutting and welding equipment
K 15	components of cutting and welding equipment such as power sources, wire feeds, regulators, tips and hoses
K 16	regulator faults such as creeping and leakage

Sub-task

A-1.01 **Maintains hand, power, layout and measuring tools.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-1.01.01	identify maintenance needs according to tool condition and manufacturers' specifications
A-1.01.02	sharpen striking tools such as chipping hammers, chisels and center punches, and remove mushroomed heads from tools
A-1.01.03	identify and sharpen dull and damaged cutting edges on twist drill bits
A-1.01.04	clean and lubricate tools and equipment after use
A-1.01.05	recognize worn, damaged and defective tools and remove from service
A-1.01.06	check accuracy and calibrate layout and measuring tools
A-1.01.07	store tools according to manufacturers' recommendations
A-1.01.08	lubricate pneumatic tools and ensure air supply is dry and clean
A-1.01.09	check safety guards, cords, switches, connectors and hoses
A-1.01.10	check fluids in hydraulic tools

Sub-task

A-1.02 Maintains stationary machinery.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-1.02.01	lock out and tag out stationary machinery prior to servicing
A-1.02.02	identify maintenance needs according to tool condition and maintenance schedule
A-1.02.03	clean machinery and remove debris such as steel shavings and off-cuts to keep work surface functional and safe
A-1.02.04	lubricate machinery according to manufacturers' specifications
A-1.02.05	check and top up coolant reservoir and change filters on drill presses and saws
A-1.02.06	inspect and replace filters in stationary machines such as fume extractors and air compressors according to jurisdictional requirements
A-1.02.07	check and adjust belt tension according to manufacturers' specifications
A-1.02.08	ensure guards, shielding and safety devices are in place according to manufacturers' recommendations
A-1.02.09	adjust tool rests on pedestal grinders and other rotating equipment to ensure safe operation
A-1.02.10	dress grinding stone on pedestal grinder according to wear pattern
A-1.02.11	inspect cutting dies and blades for damage such as chips, nicks and missing teeth to ensure safe operation and quality product
A-1.02.12	inspect forming dies for damage and debris
A-1.02.13	recognize worn, damaged and defective parts in stationary machinery, and remove them from service

Sub-task

A-1.03 Maintains thermal cutting equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-1.03.01	identify hazards and tag out/lock out cutting equipment
A-1.03.02	clean or blow out power source for cutting equipment

A-1.03.03	detect leaks using methods such as creep test, and repair the leaks
A-1.03.04	repair or replace damaged gas and air lines to cutting equipment
A-1.03.05	perform diagnosis of cutting equipment problems such as inconsistent operation and poor quality of cuts
A-1.03.06	clean and store cutting equipment
A-1.03.07	clean or replace consumables such as tips, diffusers, electrodes and nozzles
A-1.03.08	identify worn, damaged and defective cutting equipment, and take corrective action such as replacement or reconditioning

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Sub-task

A-1.04 Maintains welding equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-1.04.01	identify hazards and tag out/lock out welding equipment
A-1.04.02	clean or blow out power source for welding equipment
A-1.04.03	identify, and repair or replace, damaged shielding gas lines and regulators for welding equipment
A-1.04.04	perform diagnosis of welding equipment problems such as inconsistent operation and poor weld quality
A-1.04.05	clean welding equipment
A-1.04.06	perform basic service on gas-driven or diesel-driven welders using procedures such as checking fluid levels and filters according to manufacturers' specifications
A-1.04.07	identify worn, damaged and defective welding equipment such as ground clamps, cables and electrode holders, and take corrective action such as replacement or reconditioning

Task 2 — Uses access and material handling equipment.

Context

Access equipment such as ladders and scaffolds are used by welders to access work areas. Material handling equipment includes rigging, hoisting and lifting equipment used to move workpieces or other material. It is important that all safety precautions are taken and that training and certification requirements are observed.

Required Knowledge

K 1	access equipment such as scissor lifts, scaffolding, ladders and aerial work platforms
K 2	material handling equipment such as overhead travelling cranes, forklifts and dollies
K 3	PPE and safety equipment used for access equipment such as fall arrest harnesses and anchor points
K 4	OH&S regulations and certification requirements for operating access equipment and material handling equipment
K 5	jurisdictional regulations, limitations and training requirements for operating access and material handling equipment
K 6	ladder safety practices such as 3-point contact and ladder slope
K 7	access equipment functions and limitations according to manufacturers' specifications
K 8	material handling components such as rigging, slings and ropes
K 9	material handling equipment and component functions and limitations
K 10	company policies and procedures
K 11	working load limit (WLL)
K 12	log books for overhead cranes and forklifts
K 13	safety shut-off buttons or switches
K 14	refuelling procedures
K 15	load weight, centre of gravity, shape and dimensions
K 16	rigging devices such as beam clamps, tag lines, spreader bars, load softeners and plate clamps
K 17	types of rigging methods such as using chokers and basket hitches
K 18	surrounding area and lift conditions

Sub-task

A-2.01 **Uses access equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-2.01.01	select access equipment such as scaffolding, ladders and aerial work platforms according to job requirements
A-2.01.02	verify scaffolding is secure, level and stable
A-2.01.03	verify footing of ladders is secure, level and stable
A-2.01.04	inspect equipment for operation and compliance
A-2.01.05	identify unsafe, worn, damaged and defective access equipment, and take corrective action
A-2.01.06	operate equipment such as scissor lifts and aerial work platforms according to manufacturers' specifications, and jurisdictional and OH&S requirements
A-2.01.07	plan travel route and account for operational range of mobile access equipment for safety
A-2.01.08	cordon off work area
A-2.01.09	perform routine maintenance such as fluid top-ups and re-fuelling on access equipment
A-2.01.10	secure and store access equipment in designated area according to company policy
A-2.01.11	lock out and tag out faulty access equipment

Sub-task

A-2.02 **Uses rigging, hoisting and lifting equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-2.02.01	select rigging, hoisting and lifting equipment such as forklifts, chain falls, carts, conveyor rollers, shop cranes and dollies according to need
A-2.02.02	identify types of material to determine weight
A-2.02.03	calculate dimensions and weight
A-2.02.04	calculate sling angles to ensure rigging is adequate for the load

A-2.02.05	plan lift and path of travel to minimize lift time and hazards, and confirm lay down area
A-2.02.06	adjust material handling equipment and secure load
A-2.02.07	cordon off work area
A-2.02.08	transfer load using rigging, hoisting and lifting equipment, and monitor load during transfer
A-2.02.09	perform and interpret hand signals
A-2.02.10	place and use tag lines when required
A-2.02.11	use dunnage and softeners to protect the rigging and load
A-2.02.12	place load in pre-selected area according to orientation required
A-2.02.13	locate and interpret load charts
A-2.02.14	perform, document and verify daily safety checks
A-2.02.15	perform inspection and confirm safe operation of material handling equipment
A-2.02.16	store rigging, hoisting and lifting equipment according to manufacturers' specifications

Task 3 — Performs safety-related activities.

Context

Welders will encounter many hazards in their work environment. It is important that welders adhere to safety training, perform thorough hazard assessments, use PPE and safety equipment correctly, and maintain a safe work environment.

Required Knowledge

K 1	PPE such as respirators, face shields, safety boots, ear protection, safety glasses, filter lenses and fall arrest harnesses
K 2	safety equipment such as fire extinguishers, safety blankets and grinder guards
K 3	location of on-site safety stations such as first aid stations, eye wash stations and muster points
K 4	evacuation plans
K 5	company and site safety policies and procedures
K 6	workers' rights and responsibilities
K 7	site-specific training such as equipment operation, working in confined spaces, use of fall protection systems and H_2S awareness
K 8	housekeeping practices

K 9	disposal and recycling procedures for materials such as pickling compounds, oils and acids
K 10	site-specific emergency procedures such as reporting hazardous spills and evacuation procedures
K 11	required ventilation for cutting and welding processes
K 12	OH&S requirements
K 13	site, shop and building layout and dangerous areas
K 14	tag-out and lock-out procedures
K 15	emergency shut-down devices
K 16	WHMIS

Sub-task

A-3.01 **Performs hazard assessments.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-3.01.01	inspect worksite to identify potential hazards such as poor ventilation, chemical spills, toxic fumes, H_2S, electrical shocks, mechanical entanglement and potential explosions
A-3.01.02	identify risks associated with changes in environmental conditions such as weather and time of day
A-3.01.03	recognize risks associated with radiographic inspections
A-3.01.04	participate in daily safety meetings with personnel to communicate hazards
A-3.01.05	report hazards according to company policy and OH&S requirements

Sub-task

A-3.02 **Maintains safe work environment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-3.02.01	participate in site orientation and safety training
A-3.02.02	handle and store hazardous materials such as acids and compressed gases in designated areas according to company policy and WHMIS
A-3.02.03	install temporary safety protection such as barriers and caution tape according to site- or shop-specific requirements
A-3.02.04	install individual locks on lock-out devices on equipment to eliminate risk of energy entering the workspace
A-3.02.05	locate and clearly identify on-site safety locations such as first aid stations, eye wash stations, muster points and fire extinguishers
A-3.02.06	practice good housekeeping
A-3.02.07	plan safe route when moving material
A-3.02.08	ensure stationary machines' range of motion is unobstructed, guarded and well-marked
A-3.02.09	ensure work site complies with requirements on safe work permits such as hot work permits and confined space entry permits
A-3.02.10	protect combustible materials, or remove them from work area

Sub-task

A-3.03 **Uses personal protective equipment (PPE) and safety equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-3.03.01	select PPE and safety equipment according to task, hazard, company policy and OH&S regulations
A-3.03.02	store and maintain PPE and safety equipment according to manufacturers' specifications
A-3.03.03	inspect for unsafe, worn, damaged, expired and defective PPE and safety equipment, and remove from service

A-3.03.04	adjust PPE such as hard hats, respirators, hearing protection and fall arrest harnesses to ensure proper fit
A-3.03.05	wear PPE and operate safety equipment according to manufacturers' specifications and safe working practices

Task 4 Organizes work.

Context In order to organize their work, welders must be able to use documents and drawings, plan their project tasks, and obtain and organize required materials.

Required Knowledge

K 1	types of documents such as drawings, bill of materials, job plans, weld data sheets, material traceability documents, weld maps and WHMIS materials
K 2	types of drawings such as detail, shop and fabrication drawings
K 3	orthographic and isometric views
K 4	colour codes for types of materials
K 5	information on quality assurance documents such as visual weld inspections, dimensional checks and test results
K 6	codes, regulations and certifications
K 7	weld specifications
K 8	site conditions and restrictions
K 9	task requirements such as space, labour, materials and supplies
K 10	approximate time required to complete project task
K 11	materials such as beams, plates, bar stock, pipe, tubing, flanges and elbows
K 12	location of material inventory
K 13	company method of identifying piece marks
K 14	imperial and metric systems of measurements
K 15	general drafting principles such as drawings, grids, scales and revisions

Sub-task

A-4.01 **Uses documentation and reference material.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-4.01.01	review drawings and plans to retrieve required information for job
A-4.01.02	interpret weld symbols and notes
A-4.01.03	use computers and software to access electronic reference material
A-4.01.04	interpret types of lines such as broken, hidden, centre and section lines
A-4.01.05	convert between imperial and metric measurements
A-4.01.06	extrapolate necessary data from drawings
A-4.01.07	use bill of materials on drawings to identify necessary components and materials for fabrication
A-4.01.08	complete work documents such as time sheets, machinery checklists and progress report sheets
A-4.01.09	interpret WPDS
A-4.01.10	locate required information in manuals such as codes, specifications and equipment manuals

Sub-task

A-4.02 **Plans job tasks.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-4.02.01	determine required equipment, material and labour to complete job
A-4.02.02	sequence order of operations based on job specifications and task scope
A-4.02.03	schedule jobs and tasks based on availability of resources and access to site
A-4.02.04	anticipate safety requirements
A-4.02.05	coordinate tasks with co-workers and other trades
A-4.02.06	set up work area
A-4.02.07	generate cut lists and parts lists from bill of materials

Sub-task

A-4.03 Organizes materials.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-4.03.01	gather materials required according to cut list, parts list and specifications
A-4.03.02	verify bill of materials by cross referencing with heat numbers and specifications
A-4.03.03	document use of inventory according to company policies
A-4.03.04	complete order sheet for out-of-stock materials
A-4.03.05	queue and orientate materials according to sequence of assembly
A-4.03.06	protect materials from damage using coverings such as sheathing, blankets and cardboard

Task 5 Performs routine trade activities.

Context

Welders perform various activities during the cutting, gouging and welding processes. With the wealth of available equipment, welders must be able to select appropriate welding processes and power sources. They must follow manufacturers' specifications, company policy and safety regulations in start-up and shut-down of equipment.

Welders use methods of marking and identification for traceability. They apply heat and regulate cooling to control chemical and mechanical properties of the material. They properly store consumables to ensure weld quality.

Quality assurance is important in this trade in order to produce quality products, save time and money, and ensure the required specifications are met. Welders use various methods of inspection to ensure quality. After the welding process, welders finish the final product to customer and code requirements.

Required Knowledge

K 1	types of materials such as ferrous and non-ferrous
K 2	inspection test plan (ITP)
K 3	non-destructive testing methods such as radiography, ultrasonic, liquid penetrant and magnetic particle examination

K 4	destructive testing methods such as a bend and tensile strength tests
K 5	visual acceptance criteria
K 6	reasons for marking material and parts such as traceability and identification for fabrication and erection
K 7	mill test reports (MTR) and heat numbers
K 8	appropriate marking devices
K 9	personalized weld identification methods such as initials and stamps
K 10	company method of assigning piece marks
K 11	measurements to be verified such as material, on-going dimensional measurements and final product measurements
K 12	pre-heat, inter-pass and post-heat applications
K 13	heat treatment methods such as annealing and tempering
K 14	heat effects on material such as expansion, contraction and distortion
K 15	hardness scales such as Rockwell and Brinnell
K 16	metallurgy of materials
K 17	cooling processes such as quenching and controlled cooling
K 18	welding consumables such as electrodes, welding wires and welding fluxes
K 19	storing requirements for consumables
K 20	cylinder storage requirements
K 21	welding processes such as SMAW, FCAW, GMAW, GTAW, MCAW and SAW
K 22	electrical characteristics such as current type, polarity, duty cycle, primary power and workpiece grounding
K 23	data sheets, codes and WPS/WPDS
K 24	manufacturers' specifications
K 25	equipment used for welding, cutting and gouging
K 26	start-up and shut-down procedures
K 27	company policies
K 28	specialty processes such as stud welding (SW), resistance welding (RW) (spot and steam) and automated welding equipment

Sub-task

A-5.01 **Performs quality inspection.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.01.01	recognize defects in materials such as surface irregularities, laminations and surface contamination
A-5.01.02	refer to drawings during visual inspection to confirm dimensions and weld specifications
A-5.01.03	identify fabrication defects such as improper fit-up and misalignment
A-5.01.04	continually check for dimensional distortion during welding process and recommend corrective measures
A-5.01.05	select and use measuring devices such as fillet weld and depth gauges to verify weld dimensions
A-5.01.06	visually inspect weld to identify faults such as porosity, undercut, cold lap, and excess or incomplete penetration
A-5.01.07	visually inspect surface imperfections such as welding spatter, gouges, stray arc strikes and sharp edges
A-5.01.08	reference identified defect to applicable codes to determine acceptability

Sub-task

A-5.02 **Marks welds, materials and parts.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.02.01	refer to drawings and specifications to determine type and size of material and part numbers
A-5.02.02	transfer identification markings such as heat numbers, grain direction, and lot and job numbers from stock material to cut parts, for traceability
A-5.02.03	stamp or mark welder identification symbol on finished welds according to job specifications

Sub-task

A-5.03 **Controls temperature of weldments.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.03.01	determine heating requirements such as pre-heat, interpass temperature and post-heat applications by referring to WPS/WPDS and job specifications
A-5.03.02	select and use temperature measuring devices such as temperature sticks, thermocouples and pyrometers to monitor temperature
A-5.03.03	apply heat using tools and equipment such as rose bud torches, tiger torches and induction heating coils, according to WPS/WPDS and job specifications
A-5.03.04	follow procedures for different alloys
A-5.03.05	maintain pre-heat, interpass and post-weld temperature according to WPS/WPDS to prevent weld defects and maintain mechanical properties
A-5.03.06	control cooling rate using methods such as insulation, heating coils and ovens

Sub-task

A-5.04 **Stores welding consumables.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.04.01	identify consumables according to product labels and specifications
A-5.04.02	identify storage requirements according to manufacturers' specifications and applicable codes
A-5.04.03	place consumables in environmentally controlled area, according to material safety data sheet (MSDS) and manufacturers' specifications and applicable codes
A-5.04.04	select and use equipment such as portable and stationary rod and flux ovens to keep consumables at desired temperature, according to manufacturers' specifications and applicable codes
A-5.04.05	detect and remove from service damaged products such as broken boxes of welding electrodes and torn bags of flux

Sub-task

A-5.05 **Selects welding processes and power source.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.05.01	determine limitations and advantages of different welding processes , according to job requirements and environmental conditions
A-5.05.02	choose process according to WPS/WPDS, job requirements, and type and thickness of material
A-5.05.03	choose power source to match welding process and amperage requirements
A-5.05.04	choose stationary or portable power source according to location of project and power availability

Sub-task

A-5.06 **Performs equipment start-up and shut-down.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.06.01	visually inspect equipment to ensure electrical, gas and air supplies are properly connected
A-5.06.02	identify damaged equipment and remove from service
A-5.06.03	follow manufacturers' specifications and applicable codes for start-up and shut-down
A-5.06.04	follow company policy and safety regulations regarding start-up and shut-down

Sub-task

A-5.07 Finishes final product.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

A-5.07.01	identify finishes according to drawings and job specifications
A-5.07.02	select and use tools and equipment such as grinders, wire wheels and buffers
A-5.07.03	ensure that welds are profiled according to specifications
A-5.07.04	fill and blend surface blemishes such as plate clamp gouges and miscellaneous defects
A-5.07.05	prepare weldments and other pieces by removing burrs, sharp corners, weld spatter and slag
A-5.07.06	chemically clean weldments to remove undesirable materials such as oils and oxides
A-5.07.07	prepare weldments for galvanizing by providing air bleeds and drain holes
A-5.07.08	attach tags to parts to ensure traceability
A-5.07.09	sort assemblies for specific finishes

BLOCK B — FABRICATION AND PREPARATION OF COMPONENTS FOR WELDING

Trends

In larger companies, it is becoming more common for parts to arrive custom cut to size according to drawing specifications.

Computer-assisted design (CAD) is increasingly being used to develop designs used by welders. As a result, some manual layout skills, such as parallel line and radial line development, have been moved off the shop floor. It is more typical for welders to work with patterns and templates that have already been produced by design offices.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 6 — Performs layout.

Context

Welders lay out materials before any fabrication procedure such as cutting, drilling, bending and welding. It is important that the layout be done properly to prevent waste and ensure proper fit and accuracy.

Required Knowledge

K 1	types of templates such as hole-punching templates, wrap-arounds, cutting templates and arc templates (sweeps)
K 2	template materials such as wood, cardboard and metal
K 3	mathematics as applicable to this trade such as fractions, geometry and decimals
K 4	imperial and metric systems of measurements and conversions
K 5	reference points and dimensions that need to be transferred
K 6	drawings and specifications
K 7	isometric and orthographic views and sketching techniques

K 8	layout tools and equipment such as compasses, trammel points, straightedges, string lines, plumb bobs, dividers and levels
K 9	material allowances for bending, braking and rolling

Sub-task

B-6.01 **Develops templates.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

B-6.01.01	determine template materials and properties such as thickness, durability and fire resistance depending on specific application
B-6.01.02	visualize flat pattern required to build the finished product
B-6.01.03	establish working point and axis to determine starting point
B-6.01.04	extend or create lines from working points
B-6.01.05	transfer dimensions from drawing to template
B-6.01.06	complete profile from transferred dimensions
B-6.01.07	cut template shape using cutting tools depending on the template materials
B-6.01.08	mark template with information such as part numbers, layout information and material required

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Sub-task

B-6.02 **Transfers dimensions from drawings to materials.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

B-6.02.01	extract information from drawings and weld symbols
B-6.02.02	determine work points such as centre lines, hole locations and end preparation lines to determine location and orientation of components according to drawings
B-6.02.03	select and use measuring and layout tools such as combination squares, measuring tapes, plumb bobs and marking devices
B-6.02.04	establish working point and axis to determine starting point

B-6.02.05	perform mathematical calculations such as conversions, ratios and proportions
B-6.02.06	consider factors such as size, material usage and seam location to maximize efficiency and quality
B-6.02.07	determine total material required by considering factors such as bend allowances, kerf and job requirements
B-6.02.08	verify layout for accuracy according to drawings, specifications, and company policies and procedures

Task 7 — Fabricates components.

Context

Fabrication is the process done prior to welding. It involves preparation of materials and fitting and assembling them. These processes are often done in conjunction with other tradespersons. It is critical that pieces be fabricated within the tolerances of specifications.

Required Knowledge

K 1	joint design and preparation
K 2	cleaning methods
K 3	assembly process
K 4	starting point
K 5	dimensional tolerances
K 6	mathematics as applicable to this trade such as fractions, geometry and decimals
K 7	imperial and metric systems of measurements and conversions
K 8	reference points and dimensions that need to be transferred
K 9	types of base metals and their characteristics
K 10	types and specifications of fastening devices such as bolts and clips
K 11	weld specifications and procedures
K 12	drawings and specifications
K 13	isometric and orthographic views and sketching techniques
K 14	layout tools and equipment such as compasses, trammel points, straightedges, string lines, plumb bobs, dividers and laser levels
K 15	material allowances for bending, braking and rolling
K 16	certification requirements and codes pertaining to tacking
K 17	types and sizes of tacks

K 18	pre-heating requirements for tacking
K 19	sequence of tacks
K 20	welding processes used for tacking such as SMAW, GTAW and wire-feed processes
K 21	welding processes to be used after tacking
K 22	the impact of tack welding on the base metals
K 23	various tacking methods such as bridge, penetrating and staggered
K 24	methods to control expansion and contraction such as using strongbacks and gussets
K 25	inspection requirements for the components such as hold points
K 26	assembly constraints such as building size and equipment limitations
K 27	types of finishes and finishing processes such as painting, galvanizing and pickling
K 28	site and company policies and procedures such as safety and orientation

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Sub-task

B-7.01 **Prepares materials.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

B-7.01.01	check components' dimensions, conditions and grade to ensure compliance with job specifications
B-7.01.02	verify all processes such as drilling, punching and forming have been completed according to drawings and specifications
B-7.01.03	clean weld areas using abrasive techniques such as grinding to remove mill scale
B-7.01.04	prepare edge for assembly by squaring or bevelling according to job specifications, tolerances and information in weld symbols

Sub-task

B-7.02 Fits components for welding.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

B-7.02.01	select and use tools and equipment such as high-low gauges, wedges, clamps, saw horses, jigs and fixtures
B-7.02.02	select and use welding tools and equipment for tacking such as SMAW, GTAW and wire-feed processes
B-7.02.03	adjoin components mechanically according to drawings and specifications using clamps and fixtures
B-7.02.04	pre-heat base metals for tacking as required by job specifications
B-7.02.05	select tacking materials and methods such as bridge tacking according to job specifications
B-7.02.06	adjoin components by tacking according to job specifications
B-7.02.07	recognize common defects in a tack such as cracks, porosity and slag inclusions, and repair using industry approved repair procedures

Sub-task

B-7.03 Assembles components.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

B-7.03.01	select and use tools and equipment such as high-low gauges, wedges, clamps, saw horses, jigs and fixtures, cranes, slings and alignment tools
B-7.03.02	determine proper sequence for assembly
B-7.03.03	set gaps and alignments and work within tolerance levels as required by specifications
B-7.03.04	fit, place and adjust components ensuring they are level, plumb and orientated according to drawings

B-7.03.05	fasten components together using mechanical fasteners such as bolts according to plans and specifications
B-7.03.06	verify assembly throughout all stages by measuring against specifications and drawings

Trends

With the evolution of technology, plasma arc cutting (PAC) equipment is becoming more precise, powerful and automated. Other common processes are laser beam and water-jet cutting. These processes are now being performed by welding machine operators as well as full scope welders.

Non-thermal cutting with equipment such as band saws and stationary power tools is an emerging trend.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 8 Uses tools and equipment for non-thermal cutting and grinding.

Context

Welders must match tools and equipment with the material being cut and ground. They must select the proper blade or disc for the task.

Required Knowledge

K 1	power tools such as circular and reciprocating saws, pedestal grinders, angle and die grinders, and beveling machines
K 2	manual hand tools such as hacksaws, files, snips, pipe cutters and chisels
K 3	types of cuts such as straight and bevel
K 4	type of material to be cut such as stainless steel, aluminium and carbon steel
K 5	clearances, speed, direction, composition and pitch
K 6	types of shears and ironworkers
K 7	uses of shears and ironworkers such as cutting plates, angle iron, and punching holes
K 8	limitations of shears and ironworkers such as type, thickness and size of material being cut
K 9	air pressure rating of pneumatic grinders
K 10	rating and types of discs such as composite, carbide and abrasive

K 11	types of blades for cutting ferrous metals, non-ferrous metals and wood
K 12	types of band saws such as vertical and horizontal
K 13	types of coolants

Sub-task

C-8.01 Selects cutting and grinding tools.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-8.01.01	identify type of material being cut or ground according to job specifications
C-8.01.02	choose tools according to cutting and grinding application, thickness of material, type of cut and tool limitation
C-8.01.03	select cutting and grinding consumables such as discs and blades according to type and thickness of material

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Sub-task

C-8.02 Cuts using stationary band saws and power hacksaws.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-8.02.01	select feed and speed rates according to material thickness and size, and manufacturers' specifications
C-8.02.02	measure material to be cut according to drawings and specifications
C-8.02.03	secure material according to manufacturers' specifications to prevent damage to blade and material, and to prevent injury
C-8.02.04	perform cut according to job specifications
C-8.02.05	verify cut parameters and cut quality to ensure accuracy

Sub-task

C-8.03 **Cuts using shears and ironworkers.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-8.03.01	select shear and ironworker settings according to material hardness, type and thickness and manufacturers' specifications to avoid blade and equipment damage
C-8.03.02	measure material to be cut according to drawings and specifications
C-8.03.03	secure material according to manufacturers' specifications to prevent damage to blade and material, and to prevent injury
C-8.03.04	perform cut according to job specifications
C-8.03.05	verify cut parameters and cut quality to ensure accuracy
C-8.03.06	adjust backstop for multiple cuts according to cut parameters to increase productivity

Sub-task

C-8.04 **Cuts using hand tools.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-8.04.01	measure material to be cut according to drawings and specifications
C-8.04.02	secure material to prevent damage to hand tools and material , and to prevent injury
C-8.04.03	perform cut according to job specifications using hand tools such as hack saws
C-8.04.04	verify cut parameters and cut quality to ensure accuracy

Sub-task

C-8.05 **Cuts using handheld power tools.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-8.05.01	select speed according to material thickness, type and hardness, and manufacturers' specifications to avoid tool damage
C-8.05.02	measure material to be cut according to drawings and specifications
C-8.05.03	secure material according to manufacturers' specifications to prevent damage to tools and material, and to prevent injury
C-8.05.04	perform cutting or grinding operation according to job specifications using tools such as reciprocating jig saws, circular saws, angle grinders and die grinders
C-8.05.05	verify cut parameters and cut quality to ensure accuracy

Task 9 — Uses oxy-fuel gas cutting (OFC) process for cutting and gouging.

Context

This task covers the selection and proper use of oxy-fuel equipment for cutting and gouging. Welders must be able to select the equipment to use according to the thickness of materials being cut. They must also be able to recognize hazards associated with this process.

This cutting process is cost-effective and versatile, requires no external power source and results in quality cuts. The equipment is portable and is used primarily for cutting carbon steel.

Required Knowledge

K 1	oxy-fuel equipment such as torches, hoses, flashback arrestors, regulators, torch bodies and tips
K 2	type and thickness of base metals
K 3	construction and safety features of types of oxygen and fuel cylinders, and delivery systems
K 4	types of regulators such as low- and high-pressure, and single- and two-stage
K 5	types of oxy-fuel gases such as acetylene, natural gas and propane
K 6	automated oxy-fuel cutting equipment such as bevellers and track cutters

K 7	base metals that can and cannot be cut using oxy-fuel cutting equipment
K 8	limitations of oxy-fuel cutting and gouging
K 9	gas characteristics such as thermal volume and temperature output
K 10	left- and right-hand threads for fuel gas and oxygen
K 11	safe locations for placement and securing of oxygen and fuel cylinders
K 12	manufacturers' specifications, jurisdictional regulations and company policies related to the assembly and setup of OFC equipment
K 13	locations and causes of flashback, backfire and leaks, and methods for prevention and solution
K 14	oxy-fuel pressure requirements for cutting
K 15	safe working pressures
K 16	types of flames such as carburizing, oxidizing and neutral
K 17	types and sizes of cutting and gouging tips
K 18	travel speed of torch
K 19	metallurgy related to oxy-fuel cutting

Sub-task

C-9.01 **Selects OFC gas and equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-9.01.01	choose type of regulators such as single and double stage, according to application and gas type
C-9.01.02	choose type of torch and size of hoses according to application
C-9.01.03	choose type and size of tip according to application
C-9.01.04	choose type of fuel gas according to availability and job task
C-9.01.05	identify and choose oxygen and fuel cylinders/manifolds by suppliers' labels
C-9.01.06	choose manual or mechanized torch cutting systems such as track and pipe beveling cutters, according to application

Sub-task

C-9.02 **Sets up OFC equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-9.02.01	move and secure oxygen and fuel cylinders to prevent damage to cylinder and property, and to prevent injury to personnel
C-9.02.02	remove cylinder caps, open and close cylinder valves to remove debris from valve, according to manufacturers' specifications
C-9.02.03	install regulators on fuel and oxygen cylinders, according to set-up procedures
C-9.02.04	install flashback arrestors at the regulators and torch according to manufacturers' specifications and jurisdictional regulations
C-9.02.05	connect hoses to regulators and torch to hoses to provide gases for cutting according to manufacturers' specifications
C-9.02.06	loosen (back-off) pressure-adjusting screws on regulators to prevent damage to regulators
C-9.02.07	open cylinder valves according to manufacturers' specifications
C-9.02.08	purge system by opening torch valves and tightening pressure-adjusting screws on regulators
C-9.02.09	close torch valves
C-9.02.10	check for leaks at all connection points with approved leak detecting solution

Sub-task

C-9.03 **Sets operating parameters for OFC equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-9.03.01	remove possible contaminants from tips by using tip cleaners
C-9.03.02	adjust working pressures on regulators according to manufacturers' recommendations for the application

C-9.03.03 light torch and adjust oxygen to fuel ratio to obtain required flame for application

C-9.03.04 perform trial cut to verify operating parameters and tip selection

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Sub-task

C-9.04 Performs cut and gouge using OFC equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-9.04.01 ignite fuel gas and adjust torch valves for type of flame such as neutral, carburizing and oxidizing

C-9.04.02 pre-heat material to kindling (auto-ignition) point, initiate cut and proceed with cutting

C-9.04.03 detect and correct defects to ensure quality of cut

C-9.04.04 adjust and maintain travel speed and torch angle taking into consideration factors such as base metal, thickness of base metal and heat input to achieve a consistent cut or gouge

C-9.04.05 recognize and correct backfire and flashback conditions

C-9.04.06 recognize defects such as creep and leaks, and remove regulators from service

C-9.04.07 shut down equipment according to safe operating procedures and manufacturers' recommendations

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Task 10 Uses plasma arc cutting (PAC) process for cutting and gouging.

Context Welders use PAC process to cut ferrous and non-ferrous material; it provides clean cuts with minimal distortion and a small heat-affected zone in the material. Typically, this process requires minimal clean-up following the cutting operation.

Required Knowledge

K 1 fundamentals of PAC process

K 2 power sources

K 3 compressed air and gas supply

K 4	air dryers and filters required on compressed air supply
K 5	types of equipment such as handheld and semi-automatic
K 6	manufacturers' specifications
K 7	coolant level for liquid-cooled equipment
K 8	cutting aids such as stand-off and circle cutting attachments
K 9	types and sizes of cutting and gouging components such as tips, nozzles and shields
K 10	travel speed
K 11	hazards such as fumes, burns, sparks, electrical shocks, noise and radiation
K 12	PPE required when using PAC
K 13	metallurgy related to PAC thermal cutting process

Sub-task

C-10.01 Selects PAC equipment and consumables.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-10.01.01	choose size of PAC system according to thickness and type of material
C-10.01.02	choose PAC consumables such as tips, electrodes and nozzles according to cutting or gouging requirements
C-10.01.03	choose manual or mechanized PAC systems such as track and pipe beveling cutters, according to application
C-10.01.04	choose air or gas according to type of material

Sub-task

C-10.02 Sets up PAC equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-10.02.01	visually check equipment and components for damage
C-10.02.02	assemble PAC components on torch head
C-10.02.03	connect torch to power source

C-10.02.04 set up regulator according to manufacturers' specifications

C-10.02.05 attach ground clamp to base metal and ensure conductivity

---

Sub-task

C-10.03 Sets operating parameters for PAC equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-10.03.01 set amperage according to thickness and type of base metal

C-10.03.02 set and check air pressure according to manufacturers' specifications

C-10.03.03 perform trial cut to check for cut defects

Sub-task

C-10.04 Performs cut and gouge using PAC equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-10.04.01 apply PAC techniques such as initiating the arc and cut, and starting at the correct stand-off distance

C-10.04.02 detect and correct defects to ensure quality of cut or gouge

C-10.04.03 recognize when components are in need of replacement

C-10.04.04 adjust and maintain travel speed taking into consideration factors such as type and thickness of base metal and heat input to achieve a consistent cut or gouge

C-10.04.05 detect equipment malfunctions such as low gas pressure and inadequate ground

C-10.04.06 use jigs and guides during cutting operations

C-10.04.07 shut down equipment according to safe operating procedures and manufacturers' recommendations

Task 11 — Uses air carbon arc cutting (CAC-A) process for cutting and gouging.

Context

The CAC-A process is used for backgouging and removing welds. This process is a fast and efficient method of gouging metals. It can also be used for cutting metals on demolition projects.

Required Knowledge

K 1	electrical characteristics such as current type, polarity and duty cycle
K 2	types and sizes of gouging torches
K 3	amperage required for task
K 4	types and thicknesses of base metals
K 5	cable (lead) size
K 6	air pressures and volumes required for task
K 7	types, shapes and sizes of carbon electrodes such as coated, non-coated, flat and round
K 8	required ventilation
K 9	power sources
K 10	depth and shape of gouge desired
K 11	air orifices positioning relative to electrode, work and direction of travel
K 12	hazards such as fumes, burns, sparks, electrical shocks, noise and radiation
K 13	PPE required when using CAC-A
K 14	air dryers and filters required on compressed air supply
K 15	metallurgy related to CAC-A processes

Sub-task

C-11.01 Selects CAC-A equipment and consumables.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-11.01.01	choose power source according to application
C-11.01.02	choose gouging torches and ground clamps according to amperage and size of electrode

C-11.01.03	choose type of carbon electrodes such as flat and round, according to application
C-11.01.04	choose size of carbon electrodes according to amount of material to be removed
C-11.01.05	choose air supply with sufficient volume and pressure according to application

---

Sub-task

C-11.02 Sets up CAC-A equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-11.02.01	visually check equipment and components for defects
C-11.02.02	attach CAC-A equipment to power source using recommended polarity, according to application
C-11.02.03	attach CAC-A equipment to air supply
C-11.02.04	attach ground clamp to base metal and ensure conductivity

---

Sub-task

C-11.03 Sets operating parameters for CAC-A equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-11.03.01	set amperage according to size, shape and type of carbon electrodes
C-11.03.02	adjust regulator to provide sufficient air pressure to CAC-A equipment

Sub-task

C-11.04 Performs cut and gouge using CAC-A equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

C-11.04.01	insert electrode into holder
C-11.04.02	ensure air holes are between electrode and workpiece
C-11.04.03	maintain electrode to work angle according to application such as depth and width of gouge
C-11.04.04	adjust carbon electrode stick-out during use according to manufacturers' recommendations
C-11.04.05	maintain travel speed to achieve desired result
C-11.04.06	detect and remove defects such as copper and carbon deposits after gouging
C-11.04.07	shut down equipment according to safe operating procedures and manufacturers' recommendations

Trends

Modified short-circuit transfer is a welding process that is user-friendly and is becoming popular due to the quality of the finished product and the cost-efficiency of the process.

Pulse welding has been in existence for many years but due to improved technologies, it is becoming commonly used.

Several specialized processes such as stud welding, orbital welding and resistance welding can be performed by welding machine operators as well as full scope welders.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 12 Welds using shielded metal arc welding (SMAW) process.

Context

SMAW is a commonly used process for joining most ferrous and some non-ferrous metals. Even though it is one of the slowest of the welding processes, it is readily available, easily accessible, very reliable, versatile and portable, and therefore it is widely used.

Required Knowledge

K 1	fundamentals of the SMAW process
K 2	weld position such as flat, horizontal, vertical and overhead
K 3	types of welding power sources and their characteristics such as constant current, alternating current (AC) and direct current (DC)
K 4	electrical characteristics such as current type, polarity and duty cycle
K 5	types of equipment components such as electrode holders, cables (leads) and ground clamps
K 6	cable (lead) size and length
K 7	type and thickness of base metals
K 8	storage requirements for consumable electrodes
K 9	electrode classifications such as tensile strength, position and composition

K 10	electrode coating composition such as rutile, cellulose, low-hydrogen (basic) and iron-powder
K 11	diameters of electrodes
K 12	metric and imperial electrode designations
K 13	manufacturers' instructions and specifications
K 14	refuelling and general maintenance checks of engine-driven power sources
K 15	WPS/WPDS
K 16	travel speed, electrode angle and heat inputs
K 17	amperage requirements for electrodes and positions
K 18	pre-heating requirements for base metals
K 19	weld defects
K 20	joint configurations such as butt, tee, edge, corner and lap
K 21	types of electrode manipulation techniques such as whip, drag and push to achieve desired bead width and shape (weave and stringer)
K 22	welding symbols
K 23	weld type such as fillet and groove
K 24	safe work practices
K 25	metallurgy related to SMAW processes

Sub-task

D-12.01 Selects SMAW equipment and consumables.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-12.01.01	select power source such as inverters, rectifiers and generators, according to job task and primary power supply availability
D-12.01.02	select electrode type and diameter taking into consideration base metal thickness and composition, joint type and position and/or WPS/WPDS to ensure fusion and avoid weld defects
D-12.01.03	select welding attachments such as ground clamps, electrode holders, and cables (leads) according to application

Sub-task

D-12.02 **Sets up SMAW equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-12.02.01	set control on power source to SMAW process
D-12.02.02	set required polarity by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-12.02.03	connect electrode holders (stingers) and ground clamps to the cables (leads)
D-12.02.04	attach ground to base metal to complete circuit

Sub-task

D-12.03 **Sets operating parameters for SMAW.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-12.03.01	interpret WPS/WPDS to determine parameters for application
D-12.03.02	set/adjust amperage according to base metal and electrode selected
D-12.03.03	verify setup by welding a test specimen of same base metal and electrode

Sub-task

D-12.04 **Performs weld with SMAW equipment.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-12.04.01	start up and shut down equipment according to safe operating procedures and manufacturers' recommendations
D-12.04.02	manipulate electrode while maintaining arc length and electrode angle, and using backhand (pull) and forehand (push) techniques to direct heat, and control penetration and build-up

D-12.04.03	manipulate electrode using techniques such as whip and drag to achieve desired bead width and shape (weave and stringer)
D-12.04.04	adjust travel speed and angle taking into consideration factors such as base metal, joint configuration, position and heat input to maintain a consistent weld profile
D-12.04.05	start, stop and properly re-start arc to ensure proper tie-ins and avoid welding defects
D-12.04.06	remove slag using tools such as wire wheels, chipping hammers and wire brushes
D-12.04.07	visually inspect weld to identify weld faults
D-12.04.08	troubleshoot SMAW equipment and process to determine cause of weld fault
D-12.04.09	correct weld faults using methods such as grinding/gouging and re-welding
D-12.04.10	finish weld showing proper tie-ins in all positions and containing no unacceptable welding defects

Task 13 — Welds using flux cored arc welding (FCAW), metal cored arc welding (MCAW) and gas metal arc welding (GMAW) processes.

Context

The FCAW is a semi-automatic process that uses tubular wire with a granular flux core, which may require shielding gas. It is widely used in production shops because of its high productivity, low operating cost and high efficiency.

The MCAW process uses a tubular wire with a powdered metal core. Some of the advantages of this process include no slag produced, very little spatter and inter-pass cleaning required, and a very high deposition rate. It is used in similar applications as the FCAW process.

The GMAW process uses solid wire for welding metals and their alloys. It is used for applications such as sheet metal, structural steel and piping. It has a low distortion rate, a high deposition rate and requires minimal cleaning.

These processes typically use a constant voltage (CV) power source and a wire feeder that supplies continuously fed wire.

Required Knowledge

K 1	fundamentals of FCAW, MCAW and GMAW processes
K 2	power sources
K 3	weld positions such as flat, horizontal, vertical and overhead

K 4	type and thickness of base metals
K 5	modes of transfer such as pulse, globular, spray, short circuit and surface tension transfer
K 6	types of regulators/flow meters, cylinders and hoses
K 7	types of shielding gases such as CO_2, argon and argon-mixes
K 8	equipment and components such as guns, nozzles, contact tips, wire feeders, drive rolls, gas diffusers and liners
K 9	types of filler wires such as solid and tubular
K 10	electrical characteristics such as current type, polarity and duty cycle
K 11	cable (lead) size and ground clamp selection
K 12	storage requirements for filler wire
K 13	filler wire classifications such as tensile strength, position and composition
K 14	WPS/WPDS
K 15	filler wire stick-out
K 16	pre-heating requirements for base metals
K 17	weld defects
K 18	joint configurations such as butt, tee, edge, corner and lap
K 19	weld type such as fillet and groove
K 20	types of gun manipulation techniques such as drag and push to achieve desired bead width and shape (weave and stringer)
K 21	welding symbols
K 22	types of guns such as air cooled and liquid cooled, and their operation
K 23	safe work practices
K 24	metallurgy related to FCAW, MCAW and GMAW processes

Sub-task

D-13.01 **Selects FCAW, MCAW and GMAW gas, equipment and consumables.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-13.01.01	select power source such as inverters, rectifiers and generators, according to the task
D-13.01.02	select shielding gas taking into consideration factors such as base metal composition, process and WPS/WPDS

D-13.01.03	select drive rolls, liners and contact tips according to diameter and type of filler wire
D-13.01.04	select nozzles taking into consideration factors such as joint type, shielding gas and transfer mode
D-13.01.05	select wire filler type and diameter taking into consideration base metal thickness and composition, joint type and position to ensure fusion and avoid weld defects
D-13.01.06	select welding attachments/equipment such as ground clamps, guns and cables (leads), regulators/flow meters, shielding gases and hoses according to application

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Sub-task

D-13.02 Sets up FCAW, MCAW and GMAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-13.02.01	set control on power source to wire feed process
D-13.02.02	set required polarity by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-13.02.03	connect cables (leads) to power source and wire feeder
D-13.02.04	connect regulator to gas supply and gas hose to wire feeder
D-13.02.05	assemble gun components such as gas diffusers, contact tips and nozzles, and connect assembly to wire feeder
D-13.02.06	install roll of wire in wire feeder
D-13.02.07	feed wire through drive rolls, liner and gun, and clip end of wire for appropriate stick-out
D-13.02.08	adjust wire drive roll tension according to manufacturers' specifications to achieve a consistent rate of wire feed
D-13.02.09	attach ground to base metal to complete circuit

Sub-task

D-13.03 Sets operating parameters for FCAW, MCAW and GMAW.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-13.03.01	interpret WPS/WPDS to determine parameters for application
D-13.03.02	set wire feed speed and voltage to match parameters according to the base metal type and thickness, size and composition of the wire, and position of the weld
D-13.03.03	set gas flow rate according to WPS/WPDS for application
D-13.03.04	verify set-up by welding a test specimen of same base metal and filler wire

Sub-task

D-13.04 Performs weld using FCAW, MCAW and GMAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-13.04.01	start up and shut down equipment according to safe operating procedures and manufacturers' recommendations
D-13.04.02	manipulate gun while maintaining filler wire stick-out and gun angle, and using backhand (pull) and forehand (push) techniques to direct heat, and control penetration and build-up
D-13.04.03	manipulate gun to achieve desired bead width and shape (weave and stringer)
D-13.04.04	adjust travel speed and angle of gun taking into consideration factors such as base metal, joint configuration, position and heat input to maintain a consistent weld profile
D-13.04.05	start, stop and properly re-start arc to ensure proper tie-ins and avoid welding defects
D-13.04.06	remove slag using tools such as wire wheels, chipping hammers and wire brushes
D-13.04.07	visually inspect weld to identify weld faults
D-13.04.08	troubleshoot FCAW, MCAW and GMAW equipment and process to determine cause of weld faults

D-13.04.09	correct weld faults using methods such as grinding/gouging and re-welding
D-13.04.10	finish weld showing proper tie-ins in all positions and containing no unacceptable welding defects

Task 14 — Welds using gas tungsten arc welding (GTAW) process.

Context The GTAW process uses a non-consumable tungsten electrode and may include the use of a hand fed filler rod. It provides high quality welds and requires minimal clean-up. It welds most ferrous and non-ferrous metals. It requires the most dexterity of all welding processes.

Required Knowledge

K 1	fundamentals of the GTAW process
K 2	weld positions such as flat, horizontal, vertical and overhead
K 3	type and thickness of base metals
K 4	automated GTAW equipment
K 5	types of shielding gases and their properties
K 6	types of regulators/flow meters, cylinders and hoses
K 7	equipment and components such as tungsten electrodes, gas lenses, collets and collet bodies
K 8	types of tungsten electrodes such as pure, thoriated, zirconiated, lanthanated and ceriated
K 9	safety hazards and procedures associated with tungsten and thorium such as radioactivity
K 10	colour codes for tungsten electrodes
K 11	filler rod diameter and composition
K 12	autogenous (no filler) welding technique
K 13	electrical characteristics such as current type, polarity and duty cycle
K 14	types of torches such as air -cooled and liquid -cooled, and their operation
K 15	amperage controls such as foot pedal, thumb control and remote
K 16	back purge and damming methods and applications
K 17	WPS/WPDS
K 18	pre- and post-flow shielding
K 19	welding symbols
K 20	storage requirements for filler rods
K 21	filler rod classifications such as tensile strength, position and composition

K 22	pre-heating requirements for base metals
K 23	weld defects
K 24	joint configurations such as butt, tee, edge, corner and lap
K 25	weld type such as fillet and groove
K 26	types of torch manipulation techniques such as forehand and backhand to achieve desired bead width and shape (weave and stringer)
K 27	safe work practices
K 28	metallurgy related to GTAW processes

Sub-task

D-14.01 Selects GTAW gas, equipment and consumables.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-14.01.01	select power source such as inverters, rectifiers and generators, according to the task
D-14.01.02	select shielding gas taking into consideration factors such as base metal composition and WPS/WPDS
D-14.01.03	select cups and diffusers taking into consideration factors such as joint type and shielding gas
D-14.01.04	select tungsten electrode and filler rod compositions and diameters taking into consideration base metal thickness and composition, joint type, position and WPS/WPDS to ensure fusion and avoid weld defects
D-14.01.05	select welding attachments/equipment such as ground clamps, torches and cables (leads), regulators/flow meters, shielding gases and hoses according to application

Sub-task

D-14.02 Sets up GTAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-14.02.01	set control on power source to GTAW process and use high frequency settings according to application
D-14.02.02	connect cables (leads) to power source
D-14.02.03	connect regulator/flow meter to gas supply and hoses
D-14.02.04	assemble torch components such as tungsten electrodes, gas diffusers, cups, collets, collet bodies and gas lenses, and connect assembly to power source
D-14.02.05	adjust tungsten electrode stick-out according to joint configuration
D-14.02.06	set required polarity by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-14.02.07	attach ground to base metal to complete circuit
D-14.02.08	dam and/or purge taking into consideration factors such as joint configuration, position and base metal composition
D-14.02.09	prepare tungsten electrode by sharpening or balling it to desired tip shape based on application

Sub-task

D-14.03 Sets operating parameters for GTAW.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-14.03.01	interpret WPS/WPDS to determine parameters for application
D-14.03.02	set amperage, polarity and frequency to match parameters according to the base metal type and thickness, size and composition of the filler rod, and position of the weld
D-14.03.03	set shielding gas flow rate, including pre- and post-flow time, according to manufacturers' recommendations for application
D-14.03.04	verify set-up by welding a test specimen of same base metal and filler rod
D-14.03.05	adjust flow rate of gas to meet purging requirements

Sub-task

D-14.04 Performs weld using GTAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	yes	NV	NV

Key Competencies

D-14.04.01	start up and shut down equipment according to safe operating procedures and manufacturers' recommendations
D-14.04.02	manipulate torch while maintaining torch angle and arc length, and using backhand (pull) and forehand (push) techniques to direct heat and control penetration
D-14.04.03	manipulate torch using techniques such as weave and stringer to deposit weld metal, while adding filler metal according to factors such as application, joint configuration, position and WPS/WPDS
D-14.04.04	adjust amperage with and without remote amperage controls
D-14.04.05	match filler rod feed, travel speed and angle of torch taking into consideration factors such as base metal, joint configuration, position and heat input to maintain a consistent weld profile
D-14.04.06	start, stop and properly re-start arc to ensure proper tie-ins and avoid welding defects
D-14.04.07	visually inspect weld to identify weld faults
D-14.04.08	troubleshoot GTAW equipment and process to determine cause of weld faults
D-14.04.09	correct weld faults using methods such as grinding/gouging and re-welding
D-14.04.10	finish weld showing proper tie-ins in all positions and containing no unacceptable welding defects

Task 15 Welds using submerged arc welding (SAW) process.

Context

The SAW process provides the highest production rate. The most difficult part of this process is setting up the equipment. It is the only wire feed process that may use AC and DC currents concurrently.

This process is mostly used on large scale productions, such as pressure vessels, tanks, bridges and ship construction.

Required Knowledge

K 1	fundamentals of SAW process
K 2	weld positions such as flat and horizontal
K 3	type and thickness of base metals
K 4	equipment supports such as booms and tracks
K 5	SAW equipment and components such as drive rolls, contact tips and hoppers
K 6	sub-arc tractors
K 7	flux recovery systems
K 8	uses of cables (leads) and ground clamps
K 9	electrical characteristics such as current type, polarity and duty cycle
K 10	control panels
K 11	storage requirements for filler wire and flux
K 12	manufacturers' specifications and limitations
K 13	welding cable sizes
K 14	WPS/WPDS
K 15	welding symbols
K 16	filler wire and flux classifications such as tensile strength and composition
K 17	filler wire stick-out
K 18	weld defects
K 19	joint configurations such as butt, tee, edge, corner and lap
K 20	weld type such as fillet and groove
K 21	safe work practices
K 22	metallurgy related to SAW processes

Sub-task

D-15.01 Selects SAW equipment and consumables.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	no	NV	NV

Key Competencies

D-15.01.01	select power source such as inverters, rectifiers and generators, according to the task
D-15.01.02	select wire and flux combination taking into consideration factors such as base metal composition and WPS/WPDS
D-15.01.03	select drive rolls, liners and contact tips according to diameter and type of filler wire
D-15.01.04	select welding attachments/equipment such as tracks, ground clamps and cables (leads) according to application

Sub-task

D-15.02 Sets up SAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	no	NV	NV

Key Competencies

D-15.02.01	set control on power source to SAW process
D-15.02.02	connect cables (leads) to power source and wire feeder
D-15.02.03	assemble components such as barrel, contact tip and nozzle
D-15.02.04	install roll of wire on equipment such as tractor or boom
D-15.02.05	adjust wire drive roll tension according to manufacturers' specifications to achieve a consistent rate of wire feed
D-15.02.06	feed wire through liner, drive rolls, barrel and contact tip, and clip end of wire for appropriate stick-out
D-15.02.07	set required polarity by adjusting selector switch or connecting cables (leads) to appropriate terminals
D-15.02.08	attach ground to base metal to complete circuit
D-15.02.09	fill flux hopper

Sub-task

D-15.03 Sets operating parameters for SAW.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	no	NV	NV

Key Competencies

D-15.03.01	interpret WPS/WPDS to determine parameters for application
D-15.03.02	set wire feed speed/amperage, voltage and travel speed to match parameters according to the base metal type and thickness, size and composition of the wire, and position of the weld
D-15.03.03	verify set-up by welding a test specimen of same base metal and wire

Sub-task

D-15.04 Performs weld using SAW equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	NV	yes	yes	yes	yes	yes	no	NV	NV

Key Competencies

D-15.04.01	start up and shut down equipment according to safe operating procedures and manufacturers' recommendations
D-15.04.02	adjust head height to maintain appropriate stick-out and to control flux coverage
D-15.04.03	maintain head orientation in relation to weldment
D-15.04.04	adjust travel speed taking into consideration factors such as base metal, joint configuration, position and heat input to maintain a consistent weld profile
D-15.04.05	recover, filter and demagnetize flux according to client requirements and manufacturers' specifications
D-15.04.06	remove slag using tools such as wire wheels, chipping hammers, pneumatic chisels and wire brushes
D-15.04.07	visually inspect weld to identify weld faults
D-15.04.08	troubleshoot SAW equipment and process to determine cause of weld faults
D-15.04.09	correct weld faults using methods such as grinding/gouging and re-welding

APPENDICES

APPENDIX A — TOOLS AND EQUIPMENT

Hand Tools

adjustable wrenches (various sizes)
broom
brushes (bristle, wire, paint)
chalk line
chisels (cold, bullpin)
clamps (C)
cylinder carts
cylinder cradles
dollies
files (flat, half-round, rat-tail, bastard)
flashlight
friction lighter
funnels
hacksaw
hammers (chipping, ball peen, claw, sledge)
hand shears
hex wrenches (metric and imperial)
hydraulic jack
knives
locking pliers
magnets
metal markers
oil can
pails (plastic and metal)
pipe cutters
pipe wrap
pipe wrenches
pliers (needle nose, MIG, slip joint)
pry bars
punches (center, prick)
rollers
scrapers (various sizes)
screwdrivers (flat, Phillips, Robertson; hex-head drivers; various sizes)
shovels (flat mouth)
snips, aviator (left-, right-handed, straight)
soapstone markers
socket sets (metric and imperial)
soldering iron
stamping tools
tip cleaners
tool boxes
vices (bench vice, chain vice)
water hose
wrench sets (open and closed ends; both metric and imperial)

Layout, Measuring and Testing Tools

ammeters
calculators
calipers
combination squares
depth gauges
feeler gauges
fillet gauges
laser levels
leak testing supplies
pyrometers
scribers
spirit levels
squares
straight edges
tape measure
temperature sticks
torpedo levels
torque wrench

micrometers
plum bobs
vernier calipers

Power Tools and Equipment

air hoses and nozzles
band saws
buffers
chop saws (cut-off saws)
circular saws
coil heating equipment
communication devices (two-way radios, cell phones, smart phones)
compressors
drills (portable, hammer, electric, magnetic)
extension cords
grinders (die, bench, pedestal, angle)
hydraulic press brake
hydraulic shears
hydrostatic equipment
impact wrenches (electric or pneumatic)
nibblers
pipe bevelling machines
pipe cutters
pneumatic equipment
portable heaters
power hacksaws
power vices
propane torch (tiger torch)
reamers (hand held or mounted on power threader)
reciprocating saws
rosebuds
routers
sanders
vacuums (wet/dry)
winches

Rigging, Hoisting and Lifting Equipment

beam clamps
beam trolley
cable clamps
chain block hoists
chains
chokers
come-alongs (cable or chain)
cranes (overhead, gantry-type, monorail, boom)
dunnage (blocking)
forklifts
jackstands
lifting rings
overhead hoists
portable boom
rope
shackles
slings
softeners
spreader bars
tirfors
tuggers

Access Equipment

aerial work platforms
angel wings
ladders
personnel basket
scaffolding
scissor lifts
swing stage

Personal Protective Equipment and Safety Equipment

air hoods
air/gas monitoring devices
aprons
body harness/lanyards
boots
coveralls
ear-plugs and ear muffs
face shields
fire blankets
fire extinguishers
fire retardant clothing
fire hoses
flashback arrestors
gloves
goggles
hard hats
masks (particle, vapour)
respirators
safety glasses
welding shield

Cutting, Gouging and Welding Equipment

cable connectors
electrode holders
electrode ovens
ground clamps
oxy-fuel cutting and welding equipment
torches (TIG, plasma, oxy-fuel, arc-air)
welding and plasma power sources
welding cables
welding guns
wire feeders

APPENDIX B GLOSSARY

ammeter	meter used to measure amperage within an electrical circuit
arc welding	process that uses an electric arc to produce a molten puddle to join metals
atomized gas	a gas formed when a liquid is dispersed as a stream of droplets
barrel	extension for the sub-arc tip; a straight torch
connector (female/male)	connectors used at the end of welding cables or torch hoses to connect cables or hoses together
consumables	materials that are consumed in the course of welding and cutting operations
contact tip	tip found at the end of a welding gun in which electricity is transferred from the gun to the consumable wire before the wire enters the weld zone
decant	to pour (a liquid) from one container into another
drive rolls	in wire feed, equipment that comes in various sizes and is used to drive wire through liner to gun contact tip
dunnage	blocking or cribbing used to support a load
electrode (rod) ovens	ovens that are maintained at a certain temperature to keep electrodes stabilized and dry
electrodes	metal filler rods of varying lengths and thicknesses which may be coated with flux or other materials to aid in welding or cutting operations
filler wire	consumable melted during the welding process that becomes part of the weldment
flashback arrestor	type of equipment that prevents possible explosions due to ignition of gases in the hoses of oxy-fuel or air/fuel equipment; new torches may have built-in flashback arrestors, eliminating the need for external one
flashback/ burnback	condition in which torch flame rapidly burns back into the torch tip making a pronounced popping sound and causing the gases to rapidly re-ignite; this is usually caused by excessively dirty torch tip or low gas pressures
flow meter	meter used in conjunction with a regulator to measure the volume of gases used in welding processes

flux	a chemical cleaning agent which facilitates soldering, brazing, and welding by removing oxidation from the metals to be joined
gas diffusers	in gas tungsten arc welding, a collet body holder that diffuses the gas and grips the tungsten
ground clamp	clamp fastened to the end of a welding cable that is then fastened onto a workpiece to allow for a completed welding circuit
guns	part of certain types of welding equipment that is actually held in the hand and is used to control the filler wire
heat treatment	any application of heat to metal assemblies for the purpose of bending, stress relieving, preheating, hardening, or tempering
inverter power sources	power sources designed to operate on a high cycle to provide high amperage in a smaller unit
magnetic particle examination	test involving magnetic yokes and iron filings to determine the existence of defects or cracks in the surface of the welds
metallurgy	branch of science that involves the chemical analysis of metals and alloys
nozzle	ceramic or metal cup located at the end of a welding gun or GTAW torch through which gases flow before travelling to work surface
pickling paste	acidic compound applied to the surface of stainless steel to replenish the oxide layer, returning the steel to its original condition
postheating	heating assemblies after final welds are complete to remove stresses, often involving wrapping the assembly in fire-retardant materials to allow even distribution of heat
preheating	heating metals to a desired temperature to aid in the welding process
puddle	pool or puddle of molten material that forms the bond between pieces that are being welded
regulator	piece of equipment that regulates the flow and/or pressure of gases through a hose
resistance welding (RW)	type of welding that requires the passage of current through the material (usually when bonding sheet materials) at a precise location and which depends on the melting together of the two pieces at that point
slag	impure or oxidized material produced during some welding operations
stick-out	amount of filler wire, tungsten, or other material protruding from the gun's contact tip or collet of the equipment

surface tension transfer	a patented controlled short-circuit transfer GMAW process to make single-sided root welds on pipe
transformer rectifiers	type of welding power source that brings in AC power and rectifies it to DC through the use of a diode

APPENDIX C

ACRONYMS

CAC-A	Air Carbon Arc Cutting
AC	Alternating Current
CAD	Computer-Assisted Design
CV	Constant Voltage
DC	Direct Current
FCAW	Flux Cored Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
ITP	Inspection Test Plan
MSDS	Material Safety Data Sheet
MCAW	Metal Cored Arc Welding
MTR	Mill Test Reports
OH&S	Occupational Health And Safety
OFC	Oxy-Fuel Gas Cutting
PPE	Personal Protective Equipment
PAC	Plasma Arc Cutting
SMAW	Shielded Metal Arc Welding
SAW	Submerged Arc Welding
SW	Stud Welding
RW	Resistance Welding
WPDS	Welding Procedures Data Sheets
WPS	Welding Procedures Specifications

WLL	Working Load Limit
WHMIS	Workplace Hazardous Materials Information System

APPENDIX D — BLOCK AND TASK WEIGHTING

BLOCK A COMMON OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	30	18	16	14	NV	10	20	20	30	20	13	NV	NV	19%

Task 1 Maintains tools and equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	20	20	19	NV	10	20	10	25	10	18	NV	NV	18%

Task 2 Uses access and material handling equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	20	20	13	NV	30	20	10	20	15	18	NV	NV	18%

Task 3 Performs safety-related activities.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	20	20	23	NV	25	20	10	20	10	28	NV	NV	19%

Task 4 Organizes work.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	20	20	19	NV	10	20	35	10	10	13	NV	NV	17%

Task 5 Performs routine trade activities.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	20	20	26	NV	25	20	35	25	55	23	NV	NV	28%

BLOCK B FABRICATION AND PREPARATION OF COMPONENTS FOR WELDING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	20	25	19	NV	25	30	15	15	10	27	NV	NV	20%

Task 6 Performs layout.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	50	50	39	NV	25	40	25	40	35	47	NV	NV	40%

Task 7 Fabricates components.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	50	50	61	NV	75	60	75	60	65	53	NV	NV	60%

BLOCK C CUTTING AND GOUGING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	22	22	18	NV	15	10	20	15	12	20	NV	NV	17%

Task 8 Uses tools and equipment for non-thermal cutting and grinding.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	20	25	26	NV	10	25	20	35	20	20	NV	NV	22%

Task 9 Uses oxy-fuel gas cutting (OFC) process for cutting and gouging.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	35	35	30	38	NV	45	25	40	20	30	27	NV	NV	32%

Task 10 Uses plasma arc cutting (PAC) process for cutting and gouging.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	30	25	17	NV	25	25	30	25	25	27	NV	NV	26%

Task 11 Uses air carbon arc cutting (CAC-A) process for cutting and gouging.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
%	20	15	20	19	NV	20	25	10	20	25	26	NV	NV

20%

BLOCK D WELDING PROCESSES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	40	40	37	49	NV	50	40	45	40	58	40	NV	NV	44%

Task 12 Welds using shielded metal arc welding (SMAW) process.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
%	40	30	30	30	NV	25	35	35	35	30	38	NV	NV

33%

Task 13 Welds using flux cored arc welding (FCAW), metal cored arc welding (MCAW) and gas metal arc welding (GMAW) processes.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
%	40	30	30	38	NV	40	35	40	35	50	42	NV	NV

38%

Task 14 Welds using gas tungsten arc welding (GTAW) process.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
%	15	30	25	21	NV	30	20	20	20	15	20	NV	NV

21%

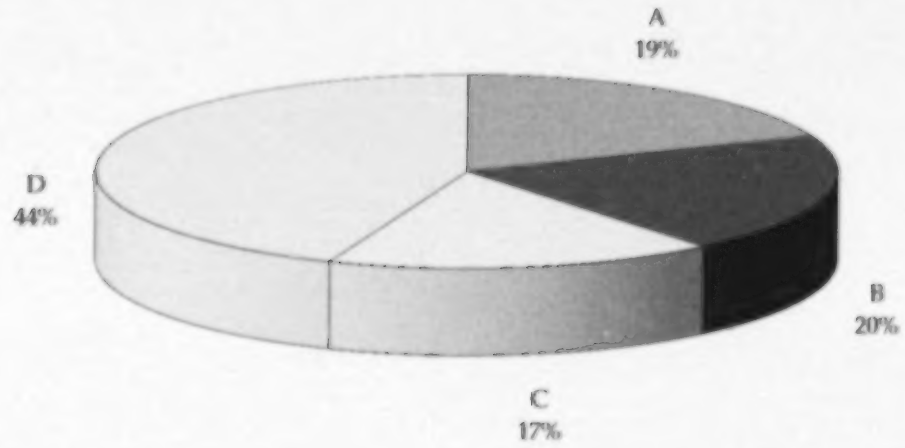
Task 15 Welds using submerged arc welding (SAW) process.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
%	5	10	15	11	NV	5	10	5	10	5	0	NV	NV

8%

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Common Occupational Skills	BLOCK C	Cutting and Gouging
BLOCK B	Fabrication and Preparation of Components for Welding	BLOCK D	Welding Processes

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART — Welder

BLOCKS	TASKS	SUB-TASKS				
A – COMMON OCCUPATIONAL SKILLS	1. Maintains tools and equipment.	1.01 Maintains hand, power, layout and measuring tools.	1.02 Maintains stationary machinery.	1.03 Maintains thermal cutting equipment.	1.04 Maintains welding equipment.	
	2. Uses access and material handling equipment.	2.01 Uses access equipment.	2.02 Uses rigging, hoisting and lifting equipment.			
	3. Performs safety-related activities.	3.01 Performs hazard assessments.	3.02 Maintains safe work environment.	3.03 Uses personal protective equipment (PPE) and safety equipment.		
	4. Organizes work.	4.01 Uses documentation and reference material.	4.02 Plans job tasks.	4.03 Organizes materials.		
	5. Performs routine trade activities.	5.01 Performs quality inspection.	5.02 Marks welds, materials and parts.	5.03 Controls temperature of weldments.	5.04 Stores welding consumables.	5.05 Selects welding processes and power source.
		5.06 Performs equipment start-up and shut-down.	5.07 Finishes final product.			
B - FABRICATION AND PREPARATION OF COMPONENTS FOR WELDING	6. Performs layout.	6.01 Develops templates.	6.02 Transfers dimensions from drawings to materials.			

BLOCKS	TASKS	SUB-TASKS				
	7. Fabricates components.	7.01 Prepares materials.	7.02 Fits components or welding.	7.03 Assembles components.		
C - CUTTING AND GOUGING	8. Uses tools and equipment for non-thermal cutting and grinding.	8.01 Selects cutting and grinding tools.	8.02 Cuts using stationary band saws and power hacksaws.	8.03 Cuts using shears and nomworkers.	8.04 Cuts using hand tools.	8.05 Cuts using handheld power tools.
	9. Uses oxy-fuel gas cutting (OFC) process for cutting and gouging.	9.01 Selects OFC gas and equipment.	9.02 Sets up OFC equipment.	9.03 Sets operating parameters for OFC equipment.	9.04 Performs cut and gouge using OFC equipment.	
	10. Uses plasma arc cutting (PAC) process for cutting and gouging.	10.01 Selects PAC equipment and consumables.	10.02 Sets up PAC equipment.	10.03 Sets operating parameters for PAC equipment.	10.04 Performs cut or gouge using PAC equipment.	
	11. Uses air carbon arc cutting (CAC-A) process for cutting and gouging.	11.01 Selects CAC-A equipment and consumables.	11.02 Sets up CAC-A equipment.	11.03 Sets operating parameters for CAC-A equipment.	11.04 Performs cut and gouge using CAC-A equipment.	
D WELDING PROCESSES	12. Welds using shielded metal arc welding (SMAW) process.	12.01 Selects SMAW equipment and consumables.	12.02 Sets up SMAW equipment.	12.03 Sets operating parameters for SMAW.	12.04 Performs weld with SMAW equipment.	
	13. Welds using flux cored arc welding (FCAW), metal cored arc welding (MCAW) and gas metal arc welding (GMAW) processes.	13.01 Selects FCAW, MCAW and GMAW gas, equipment and consumables.	13.02 Sets up FCAW, MCAW and GMAW equipment.	13.03 Sets operating parameters for FCAW, MCAW and GMAW.	13.04 Performs weld using FCAW, MCAW and GMAW equipment.	

BLOCKS	TASKS	SUB-TASKS			
	14. Welds using gas tungsten arc welding (GTAW) process.	14.01 Selects GTAW gas, equipment and consumables.	14.02 Sets up GTAW equipment.	14.03 Sets operating parameters for GTAW.	14.04 Performs weld using GTAW equipment.
	15. Welds using submerged arc welding (SAW) process.	15.01 Selects SAW equipment and consumables.	15.02 Sets up SAW equipment.	15.03 Sets operating parameters for SAW.	15.04 Performs weld using SAW equipment.